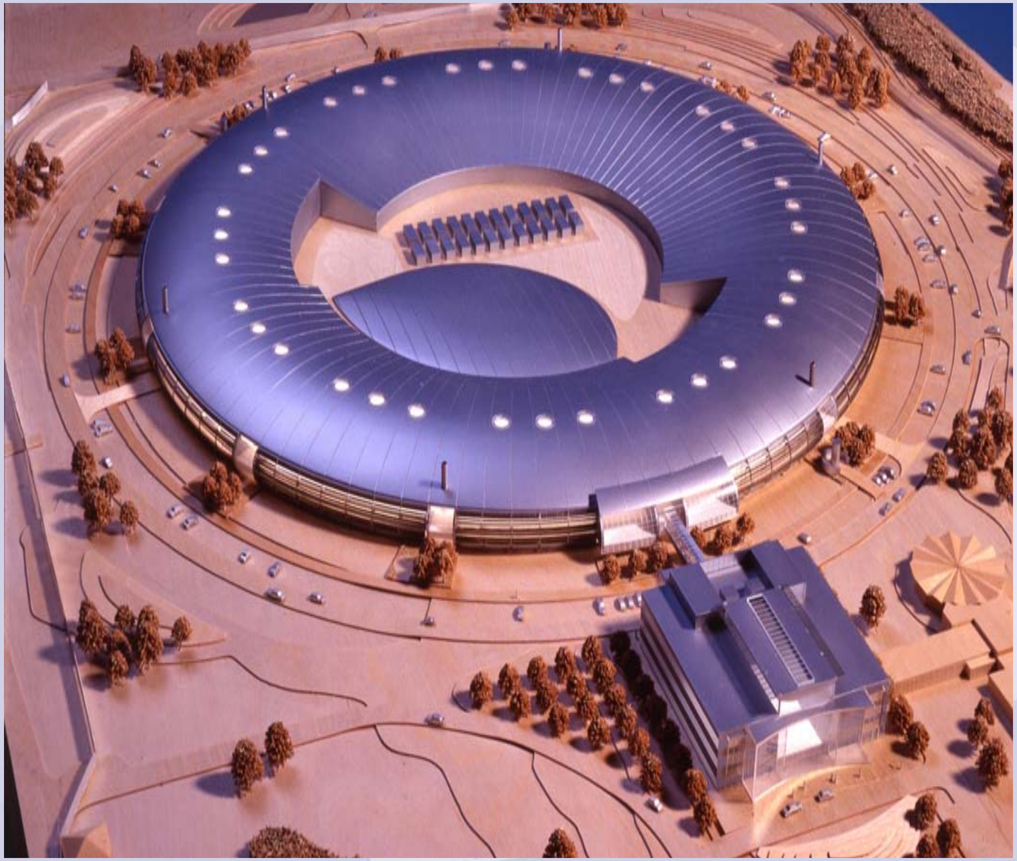
Overview of the Diamond Light Source Project



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Diamond

- Diamond is the new UK Synchrotron Light Source
- Located at the Rutherford Appleton Laboratory (RAL) Oxfordshire
- Due online early 2007 (First beam SR Jan 2006)
- Designed to complement the ESRF
  - **UK has 14% stake in**

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Master Schedule

Appoint Main Building Contractor	Jan. ’03
Start enabling works	Mar. ’03
Start main building works	Oct. ‘03
Start machine installation	Sep ’04
Start beamlines installation	Jan. ’05
Linac commissioning	May – Jul. ’05
Booster commissioning	Sep. – Nov. ’05
Storage ring commissioning	Jan. – Dec. ’06
Beamlines commissioning	May – Dec. ‘06
Start of Operations	Jan. ’07

Location of Diamond in the UK

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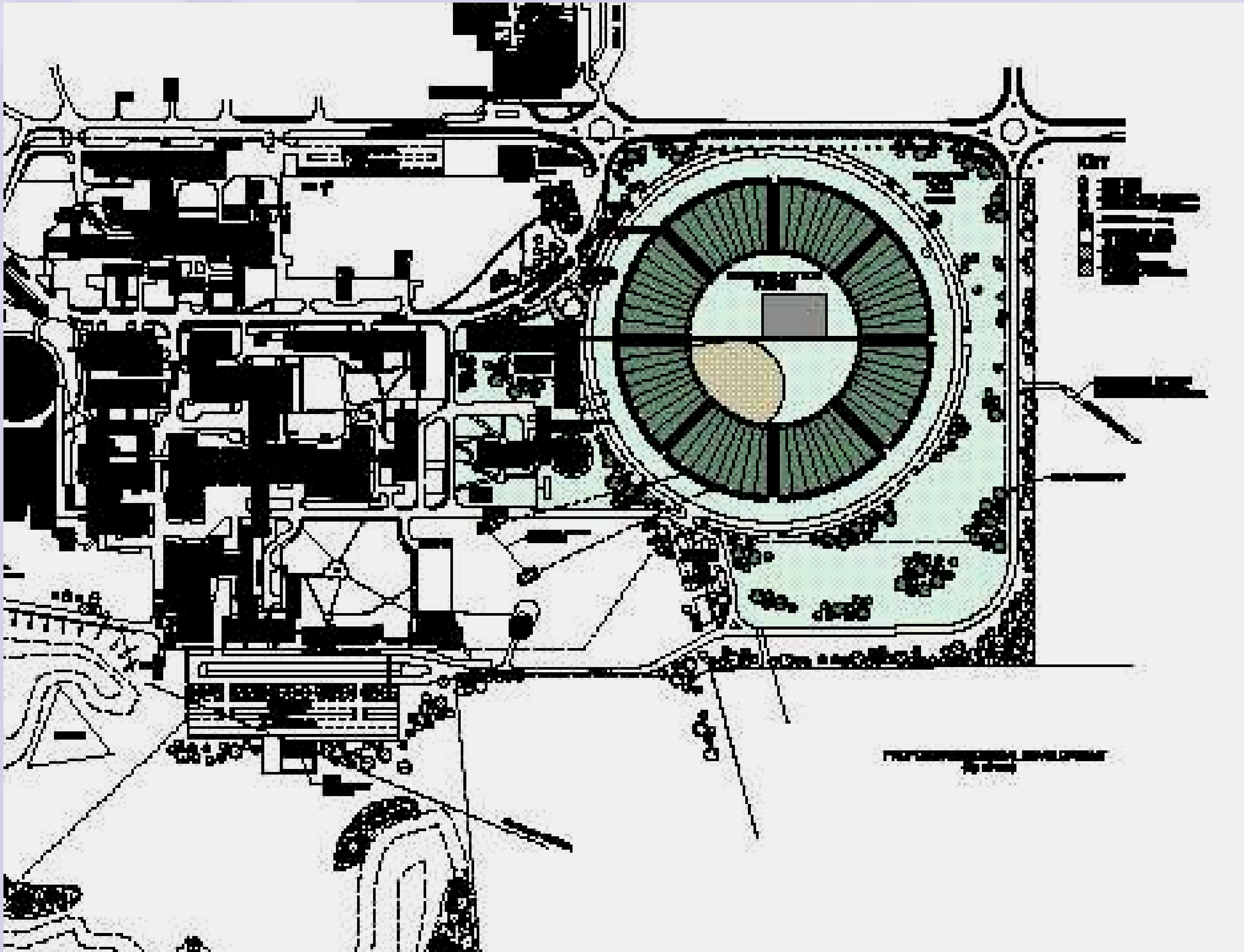
Location on the RAL Site



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Diamond Design Criteria

- Large capacity for Insertion Device beamlines
- High brightness from undulators optimised in the range 0.1-10 keV, extending to 15-20 keV
- High flux from wigglers from 20-100 keV
- Cost constraint

➔ "medium" light source energy of 3 GeV

➔ relatively large circumference (562 m) and no. of cells (24)

➔ extensive use of in-vacuum undulators

Main Parameters

		Goal:
Electron Beam Energy	3 GeV	
Storage ring circumference	561.6 m	
Number of cells	24	
Symmetry	6	
Straight section lengths	6 x 8 m, 18 x 5 m	
No. Insertion devices	4 x 8 m, 18 x 5 m	
Beam current	300 mA	(500 mA)
Emittance (hor., vert.)	2.7, 0.03 nm rad	
Lifetime	> 10 h	(20 h)
Min. ID internal gap	7 mm	(5 mm)
Synchrotron radiation power *(at 300 mA, without Insertion devices)*	300 kW	

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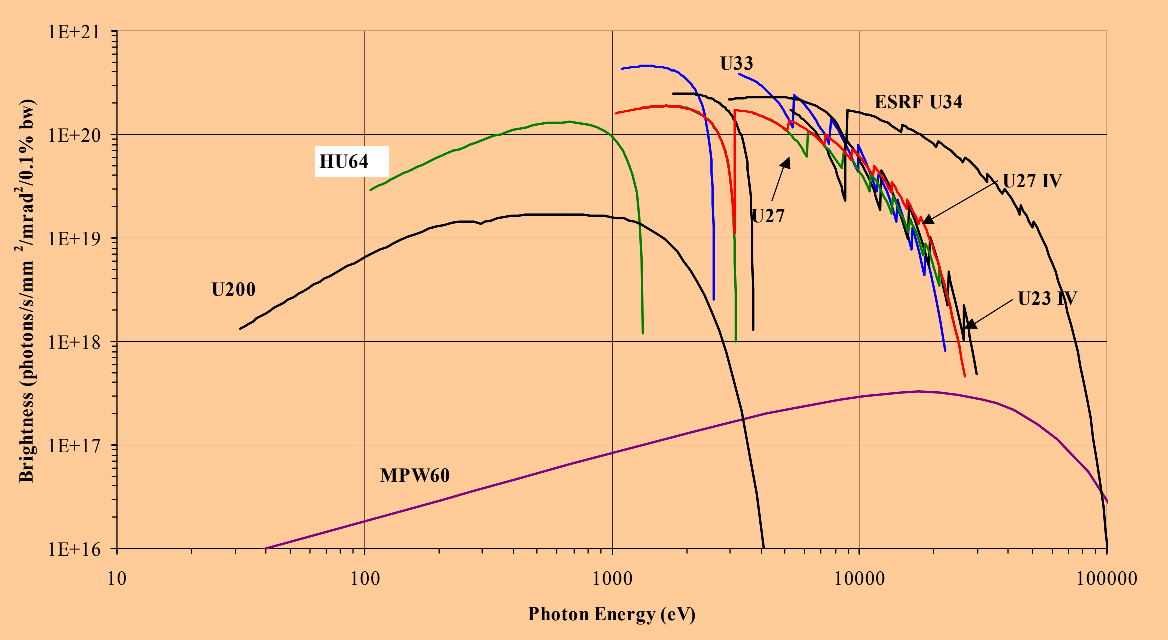
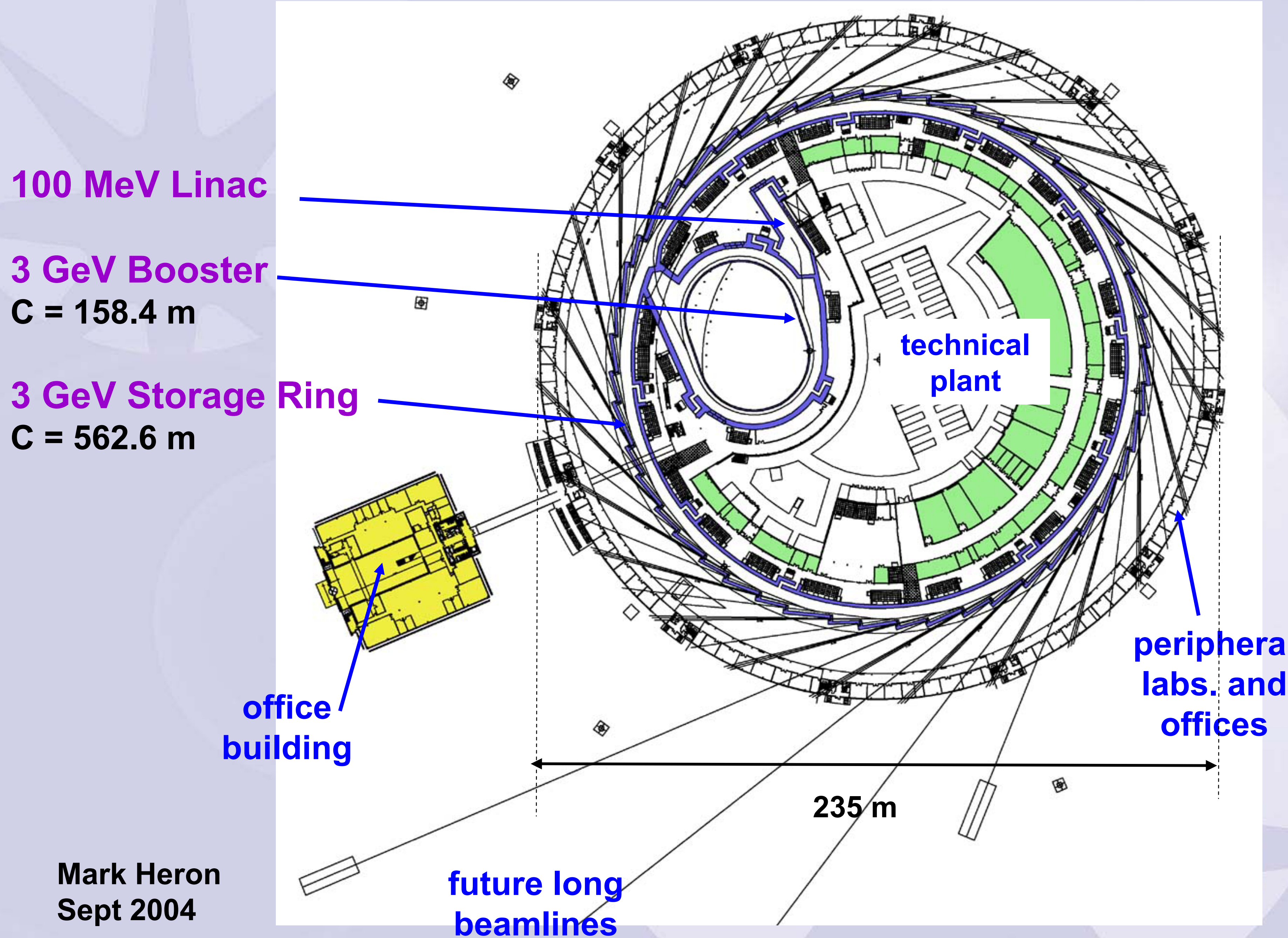


Diamond performance

DIAMOND Beam Sizes

	5 m Straight	*8 m Straight*
σ_x	*79.9 μm*	*166.0 μm*
σ_x'	*35.0 μrad*	*15.6 μrad*
σ_y	*7.8 μm*	*15.6 μm*
σ_y'	*3.1 μrad*	*1.6 μrad*



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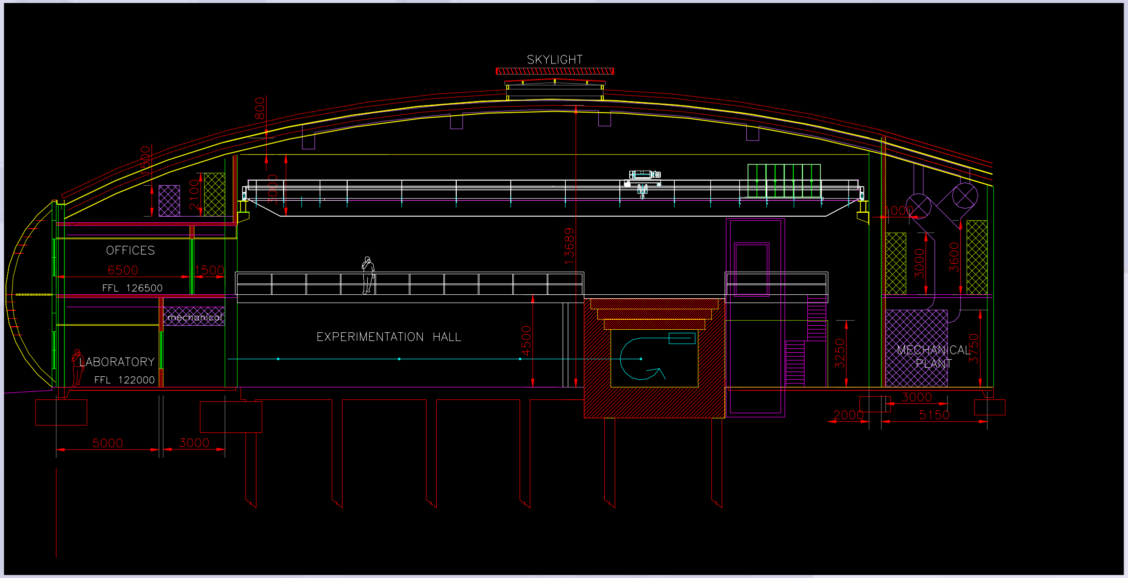
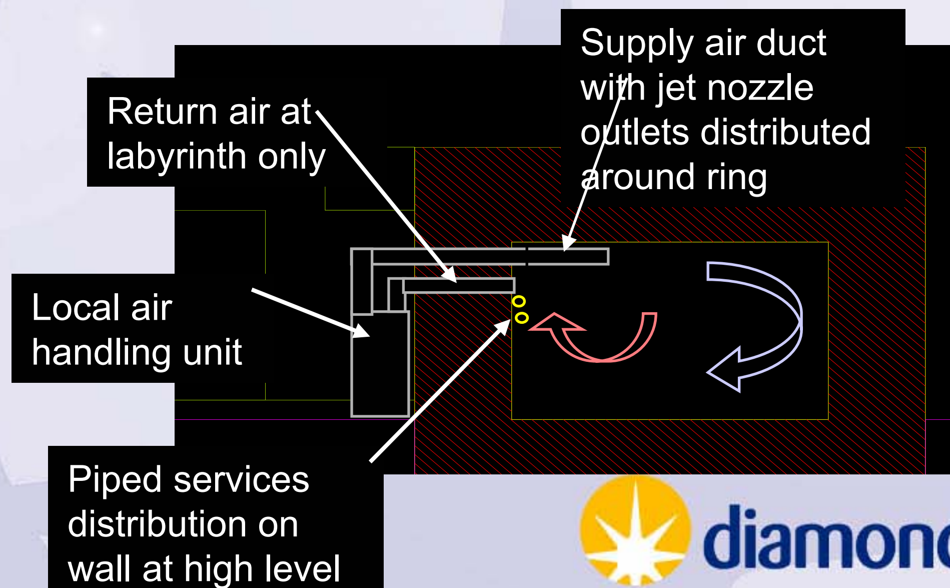
Diamond buildings: detailed design



STABILITY:
minimise thermal variations

experimental hall +/- 1 °C

storage ring tunnel +/- 0.5 °C



Courtesy of JacobsGibb Ltd.

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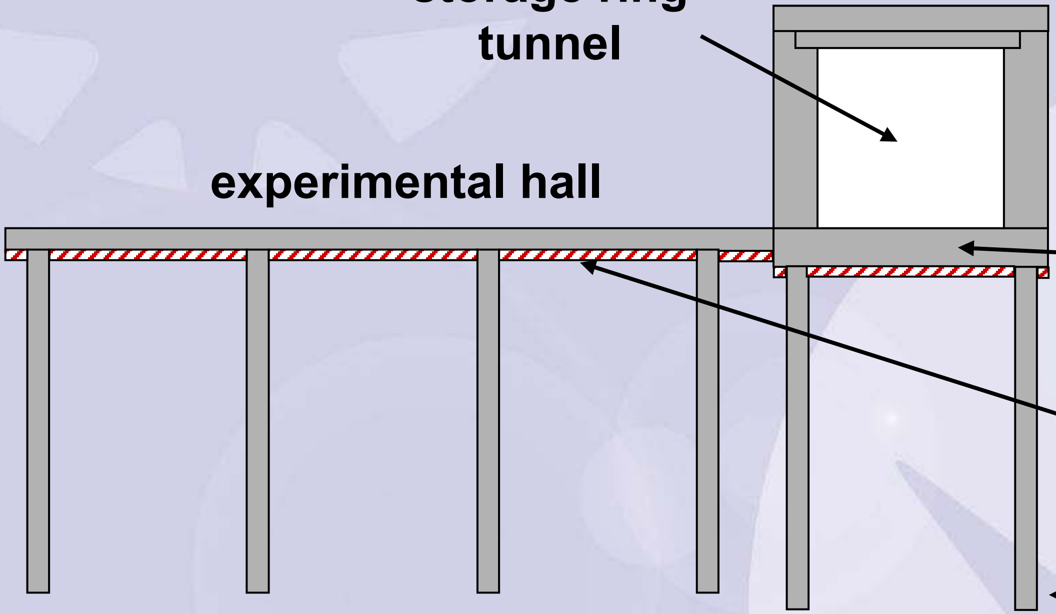
Building Foundations

STABILITY: minimise ground movement, and transmission of vibrations

piling rig:

storage ring tunnel

experimental hall



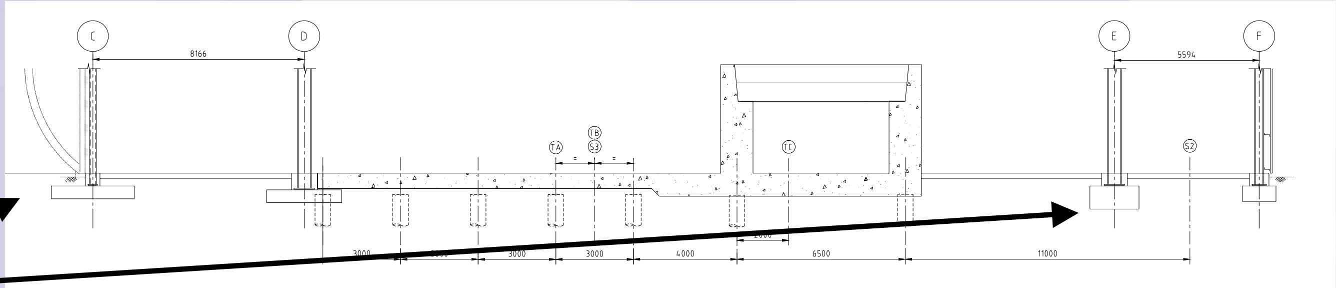
0.6-0.85 m thick concrete slab

void to isolate slab from the ground

1523 piles, 12-15 m deep

600 mm diam., 3 m apart

NB] separate non-piled foundation for the building structure and plant rooms



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Linac

- **'Turn-key' contract for 100 MeV Linac includes installation and commissioning to a performance spec.**

  DLS supplies vacuum, controls and diagnostic equipment.

- **Main parameters**

max. frequency	**5 Hz**
multibunch charge	**$\geq$ 3 nC**
multibunch pulse length	**300 ns**
single bunch charge	**$\geq$ 1.5 nC**
normalised emittance	**$\leq$ 50 mm mrad**
energy spread	**$\leq \pm$ 1.5 %**
top-up capability	low charge, variable pulse sequences etc.

- **Technical solution:**

  - 500 MHz modulated thermionic gun
  - 500 MHz pre-buncher, 3 GHz pre-buncher and buncher
  - two 5.2 m constant gradient accelerating sections fed by separate 35 MW klystrons

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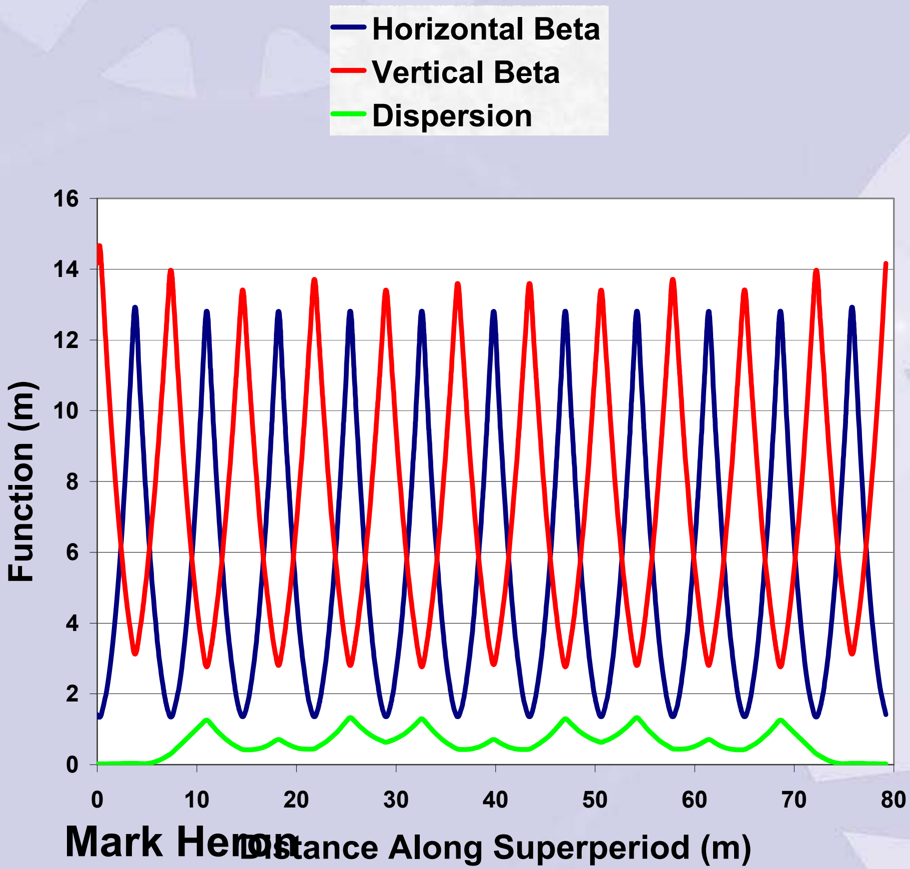
Booster

- 22 Cell FODO lattice with 36 dipole magnets
- Missing dipole straights used for injection, extraction, RF and diagnostics



Injection energy	100 MeV
Circumference	158.4 m
Current, max	6 mA
Emittance	135 nm rad
Tunes	7.16, 4.11
Nat'l chromaticity	-0.3, -6.2
Frequency	5 Hz

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Booster

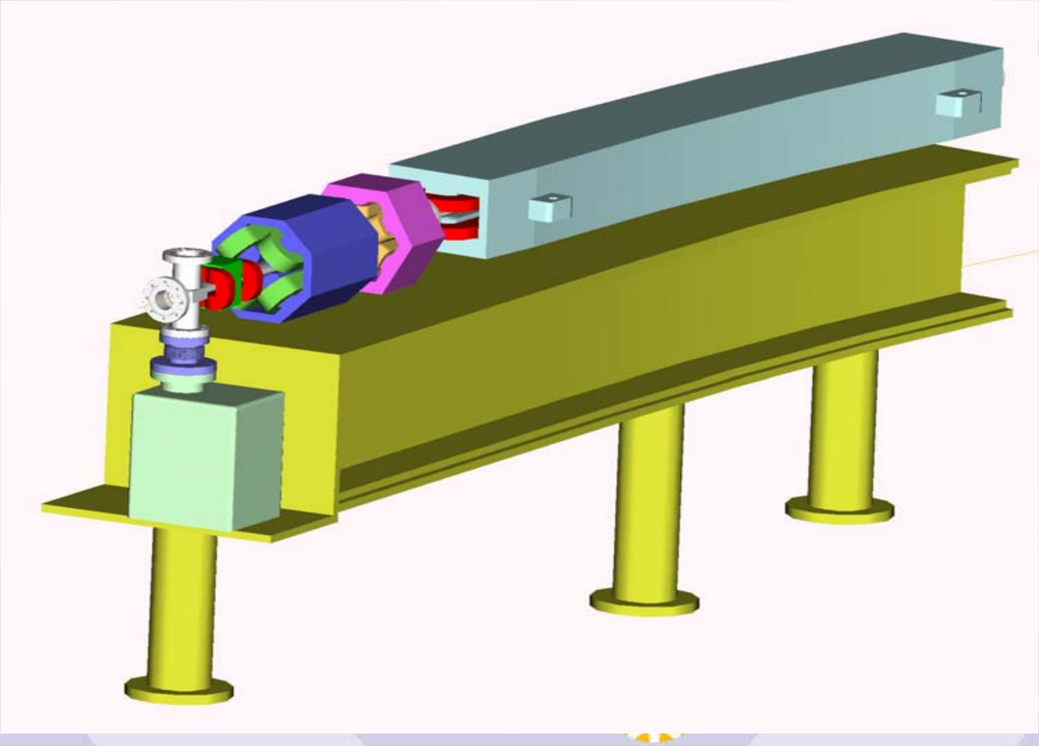
	Beam-stay-clear	Vac. vessel int.	Magnet
dipoles	44 x 16 mm	46 x 17.2	gap = 21 mm
quads & sexts	50.4 x 17.8 mm	52 x 24	ro quad = 21 mm ro sext = 24 mm

rms Power = 137 kW

Call for Tender for
“magnet and vacuum assembly units”
about to be made
(86 % of the booster circumference)

Separate procurement of other components

Installation and assembly by DLS



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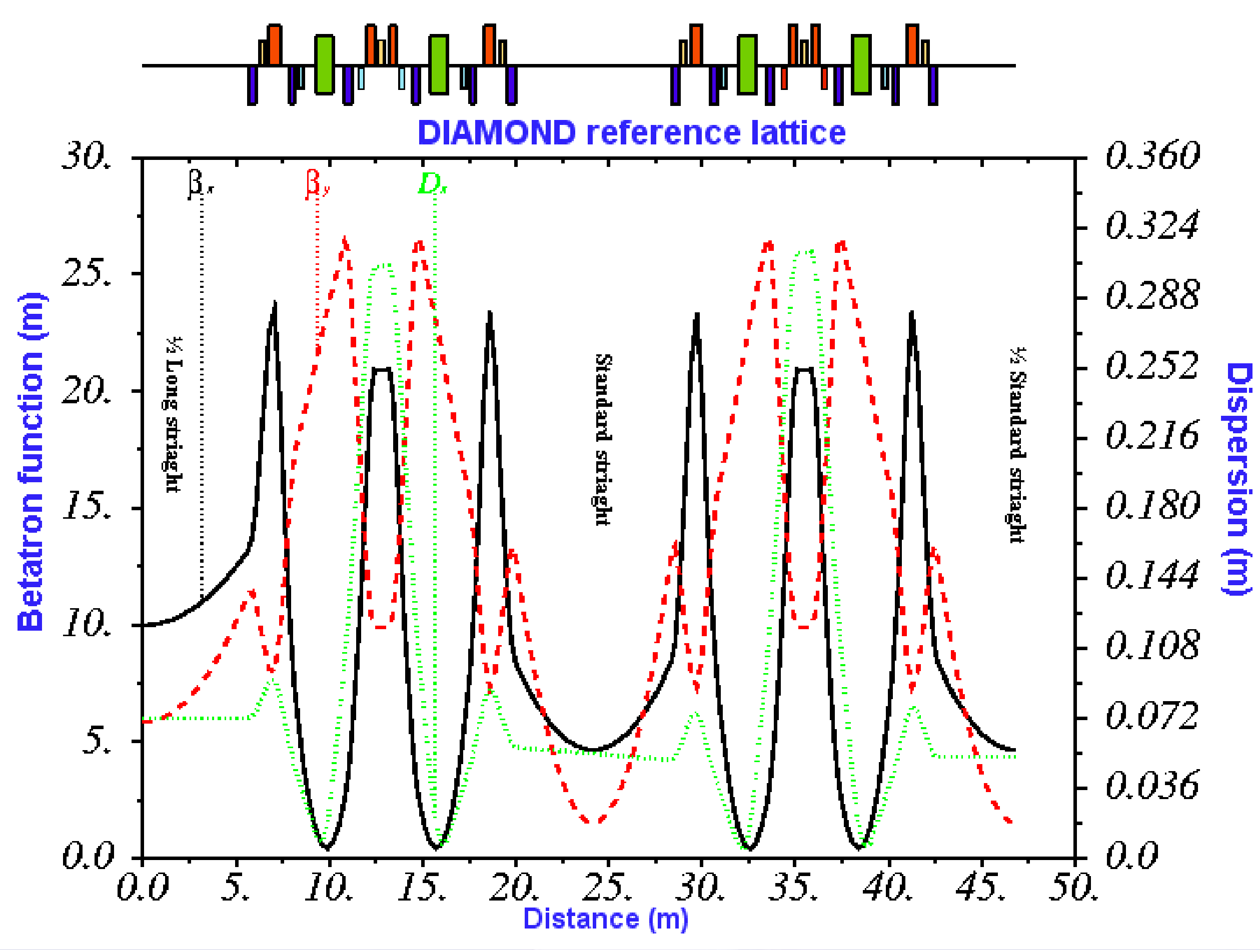
Storage Ring

Lattice has remained the same as reported at EPAC '02



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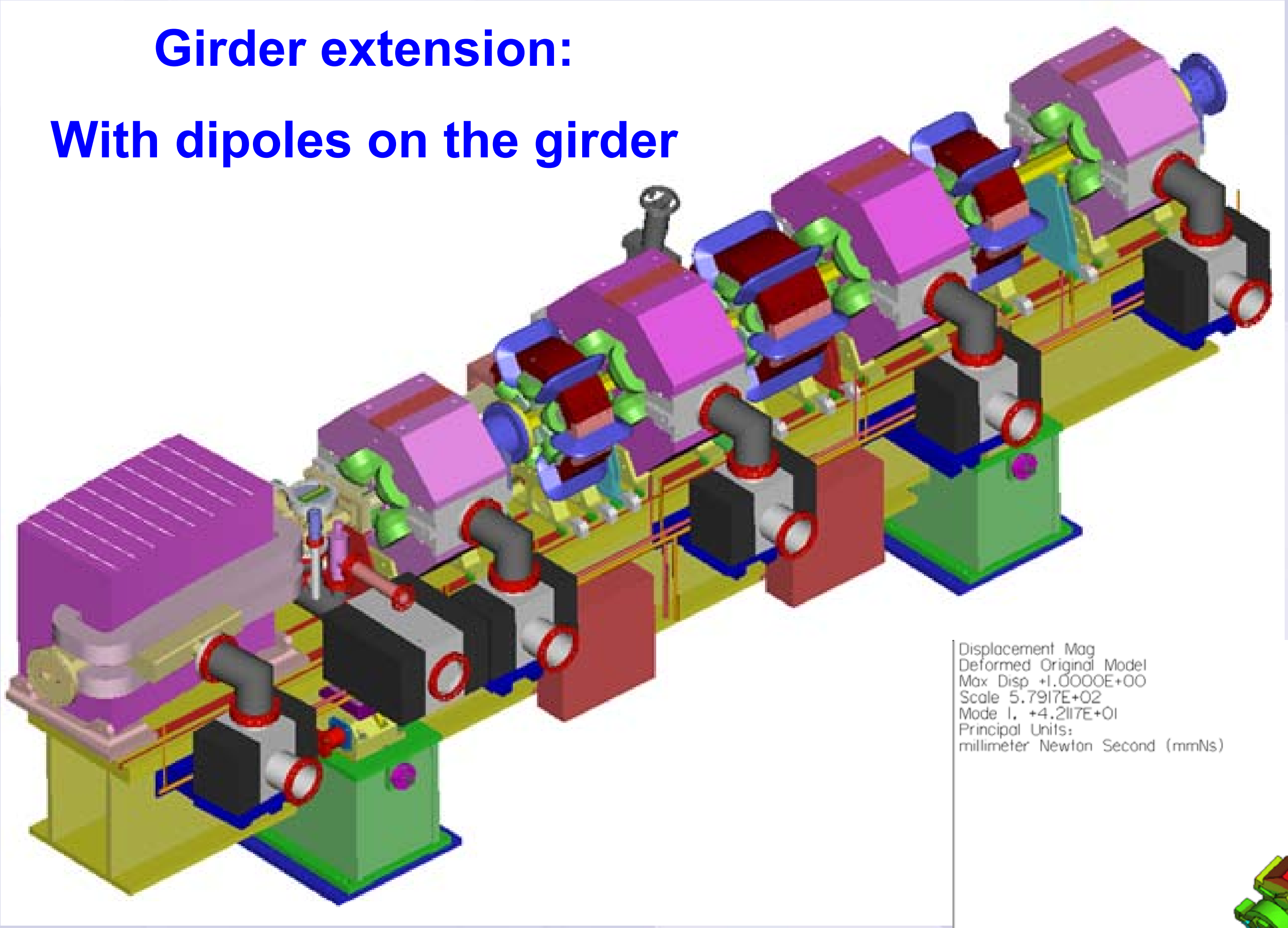
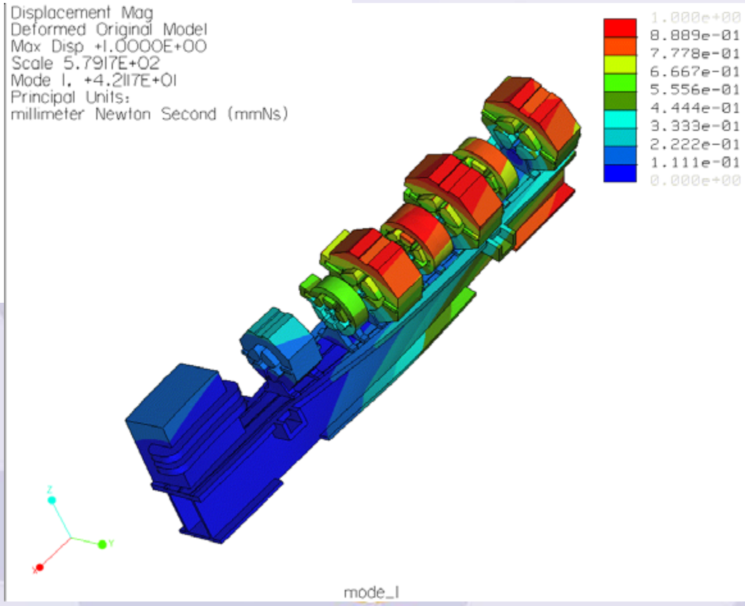
Girder extension:

With dipoles on the girder





modal shows lowest frequency of 42 Hz

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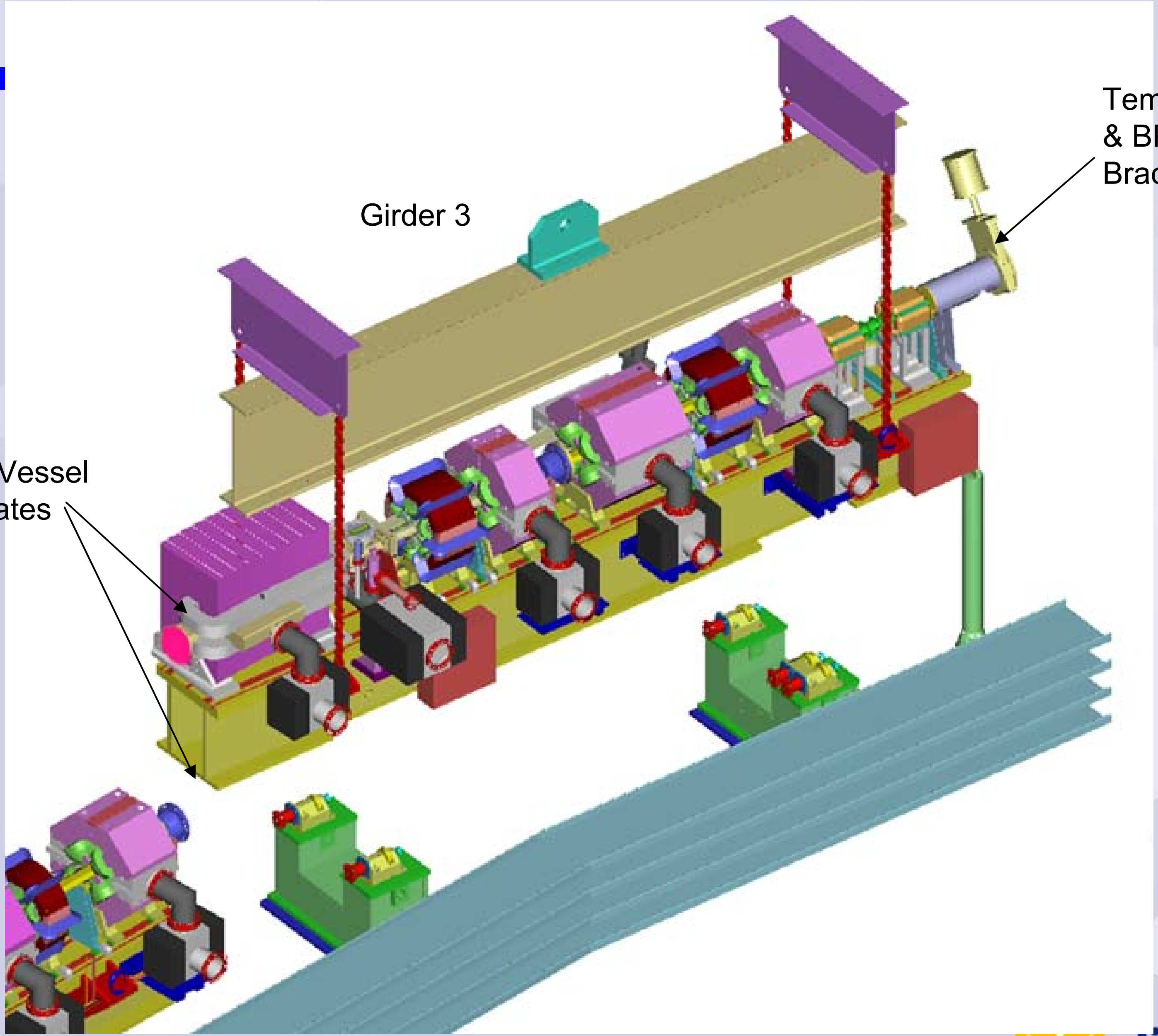
Girder



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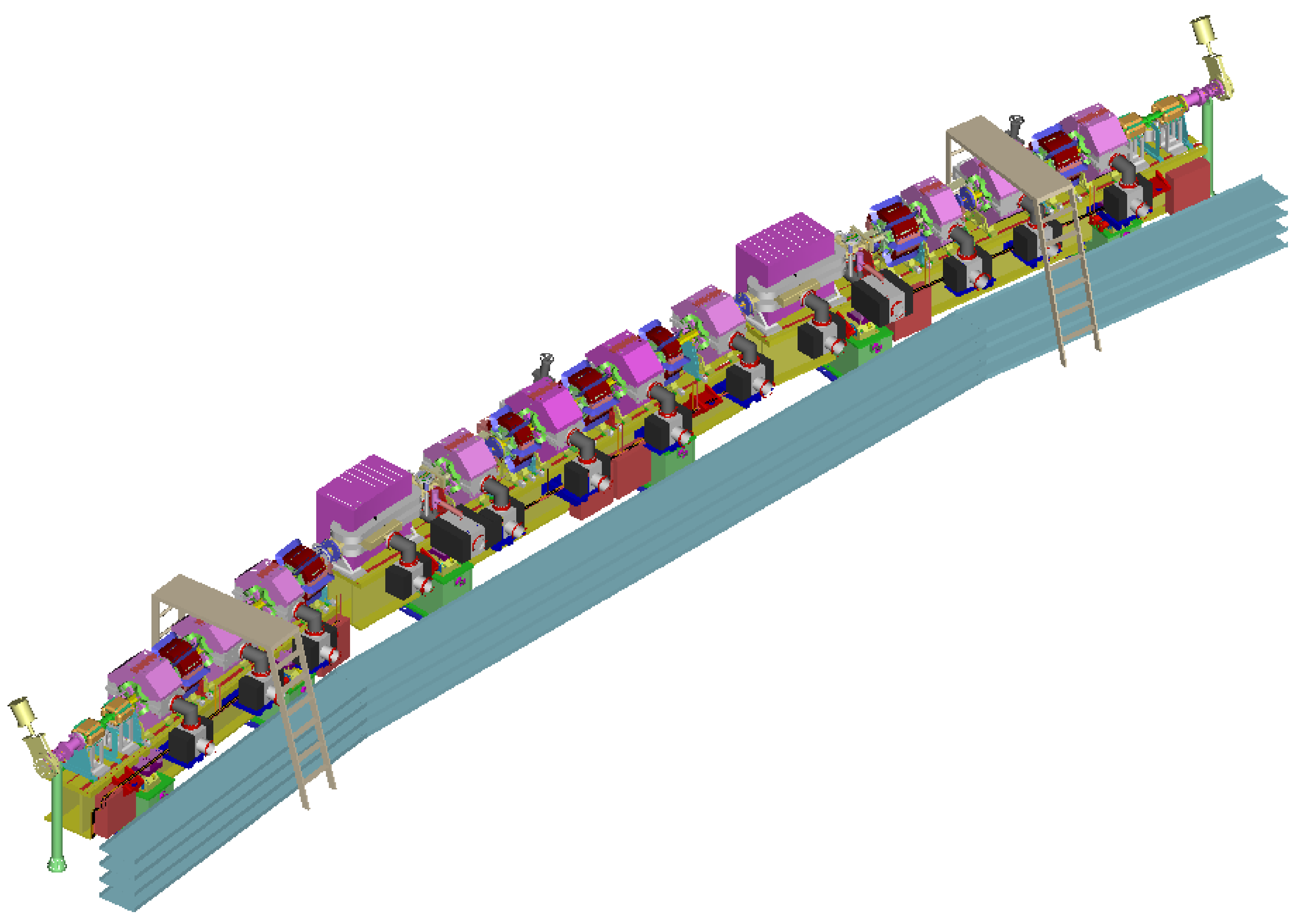

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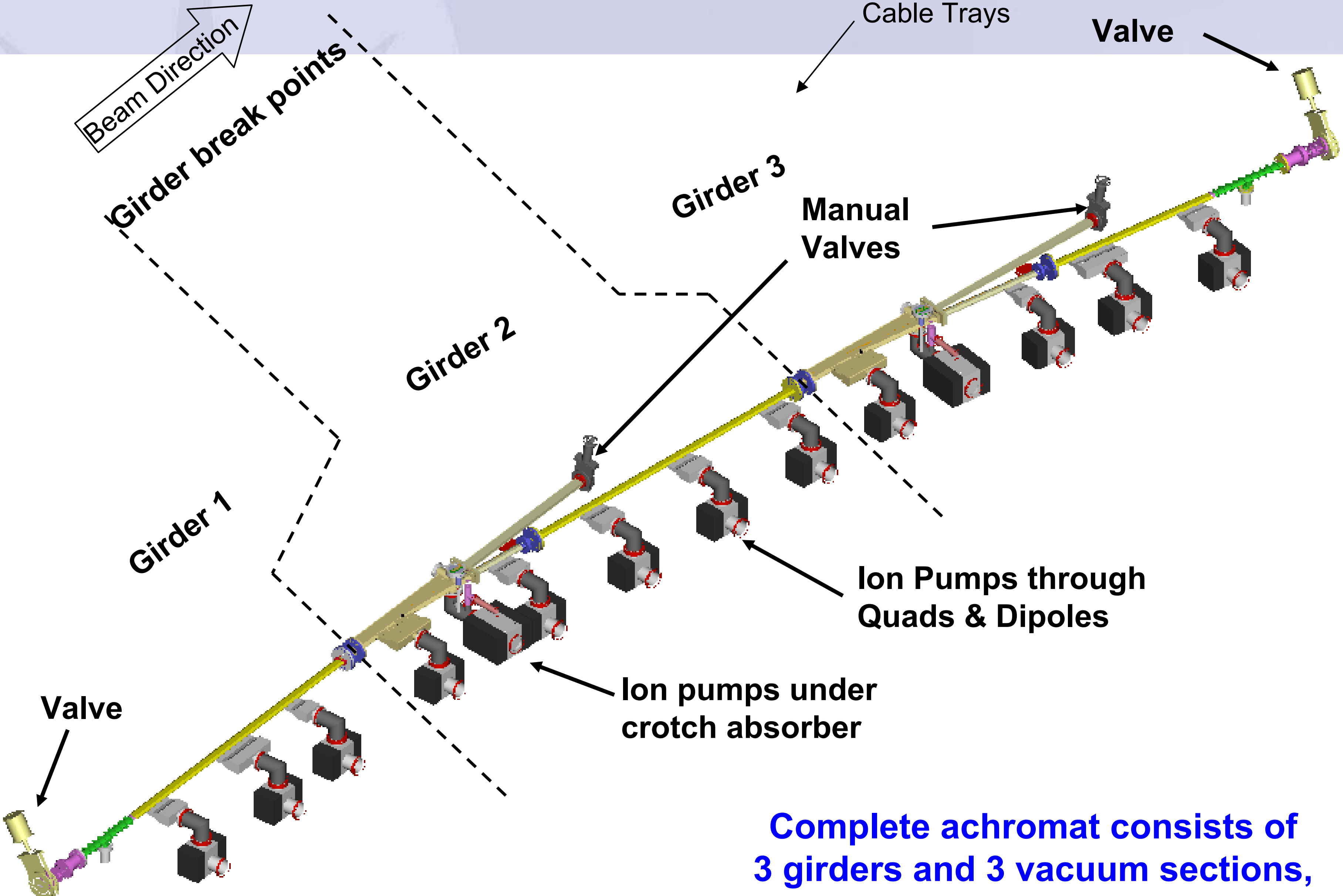

Complete achromat consists of 3 girders and 3 vacuum sections, pre-baked and installed under vacuum, no in-situ bakeout

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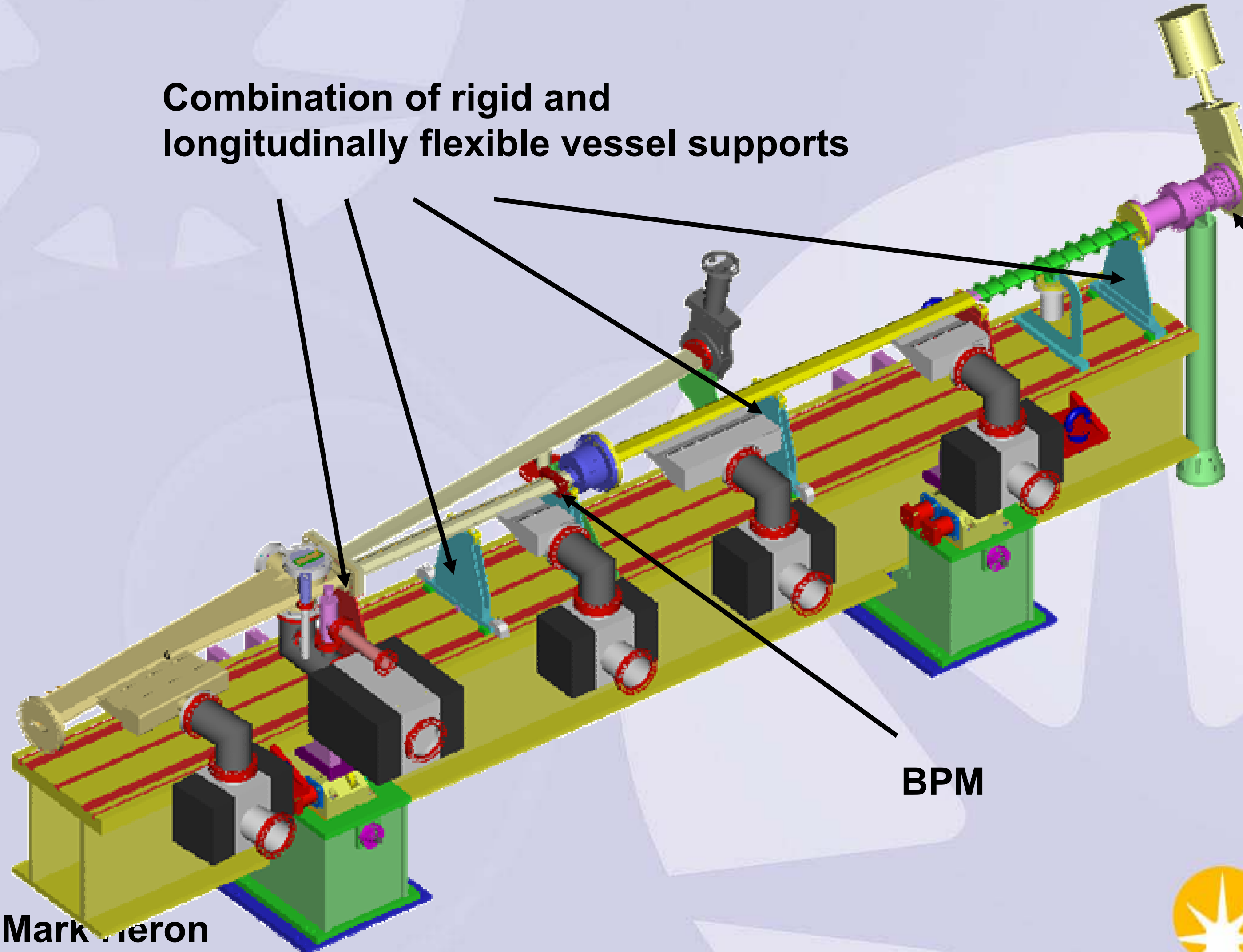
Vacuum vessel and BPM supports



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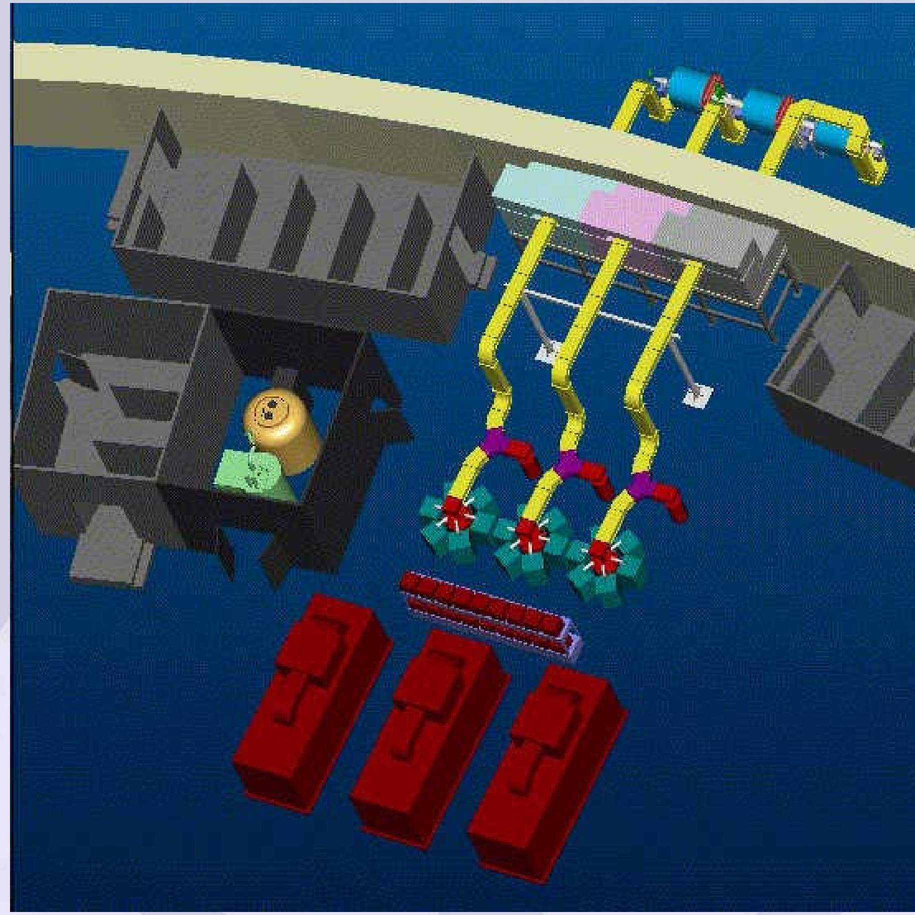
Power Supplies

- 1200 Switched Mode Power Converters for DC and Low Frequency Magnets.
- 10 Pulsed Power Supplies to transfer the electron beam from Linac to Booster and Booster to Storage Ring.

	Number	Current (A)	Voltage (V)	Frequency (Hz)
Storage Ring				
Dipole	1	1500	500	DC
Quadrupole	240	200	30	DC
Sextupole	168	100	20	DC
Fast Corrector	192	± 16	± 55	1000
Slow Corrector	504	± 5	± 20	50
Booster				
Dipole	1	975	2000	5
Quadrupole	2	200	400	5
Sextupole	2	20	50	5
Corrector	44	± 5	± 20	50

Superconducting RF System

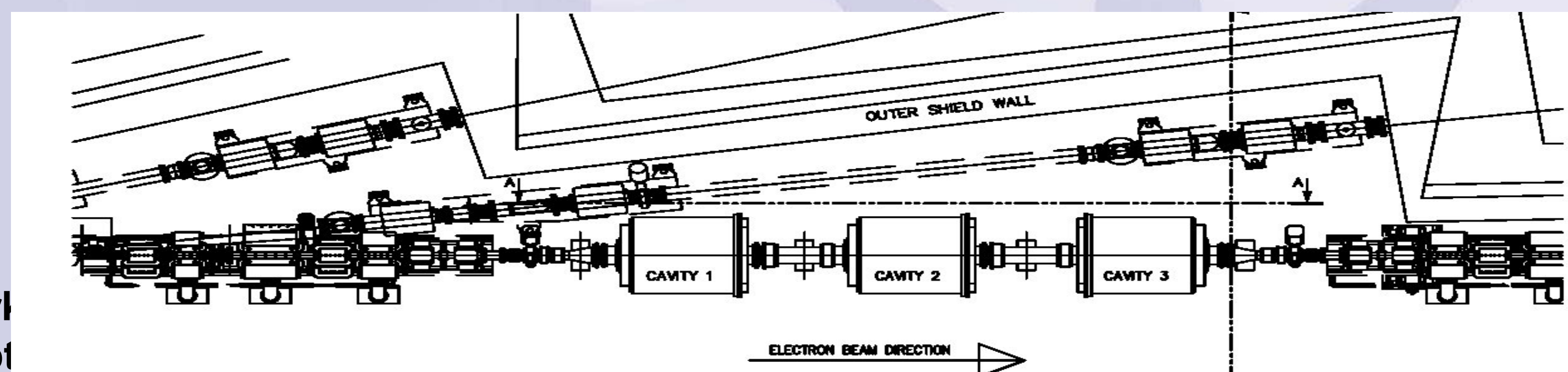


2 s/c RF cavities for Day 1 (7 IDs and 300 mA)

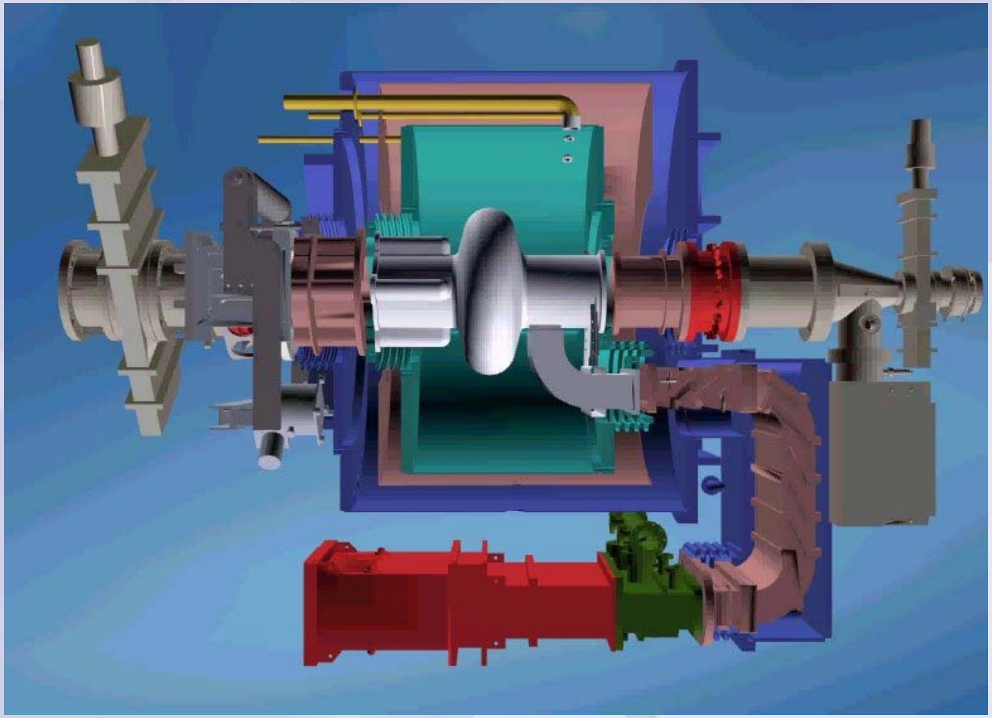
3rd cavity being designed in

independent RF systems (IOTs/klystron)

CFTs issued for cavities and amplifiers



Super conducting Cavity from Accel



schematic of a storage ring cavity

Cavities: 3 × superconducting cavities, operating temperature -269ºC

Power Amplifiers: 3 x 300 kW power amplifiers (500 MHz)

Cryogenic System: capable of producing ~ 200 L of Liquid helium from warm gas / hr; completely enclosed system ensuring no loss of helium

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Insertion devices (Phase I)

Name	Period (mm)	Length (m)	Type
MPW60	60	1.0 – 2.0	3.5T s/c wiggler
U33	33	4.9	standard
U23 Iva	23	2.0	in-vacuum
U23 IVb	23	2.0	in-vacuum
U21 IV	21	2.0	in-vacuum
U27 IV	27	2.0	in-vacuum
HU64	64	2 x 2.2	APPLE-2

Being designed and constructed “in-house”
(currently by the ASTeC ID Group at CCLRC-Daresbury)

Designs well advanced and purchasing about to start

Diamond Phase-I Beamlines

- **Protein crystallography (3 beamlines)**
  For the determination of the structure of macromolecules with rapis sample through-put.
- **Extreme conditions**
  Study of materials at very high temperatures and pressures, typical of planetary interiors and industrial processes.
- **Materials and magnetism**
  Study of materials including magnetic systems, high temperature superconductors
- **Microfocus**
  chemical imaging and structural studies of complex multicomponent systems with sub-micron resolution
- **Nanostructures**
  To study the morphology, chemical and magnetic state of nanostructures with <10 nm resolution.

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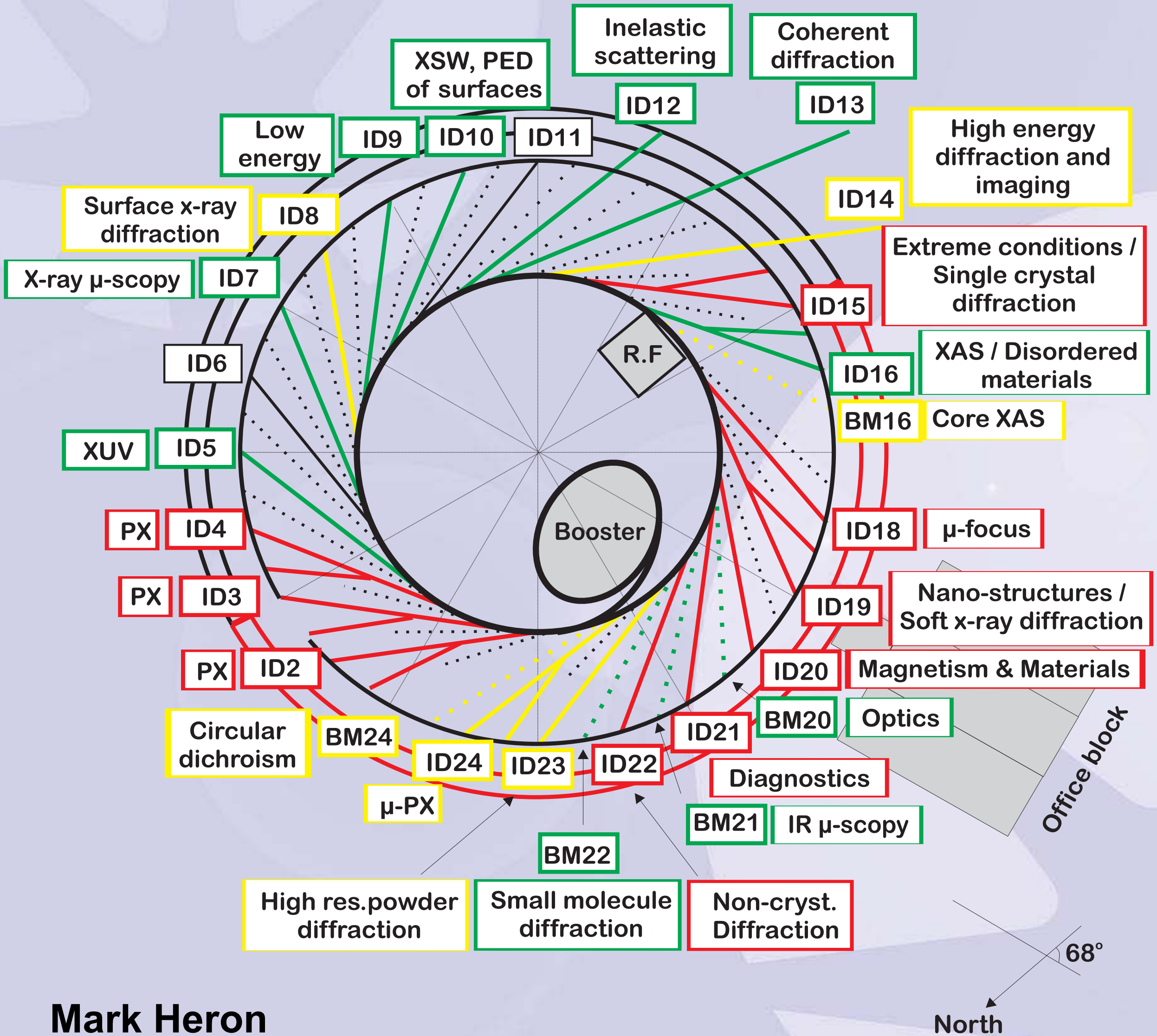
Future Beamlines



Being constructed, 7 Phase One + Phase 2 NCD Beamlines

Being Considered for Phase 2

Possible future Beamlines Proposals

Go-ahead has been given to start the design and construction of 14 Phase 2 beamlines

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Storage Ring
Building
Jan 2004


Storage Ring
Building
March 2004


Booster
March 2004

Office Block
March 2004

Storage Ring Building Sept 2004

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Sept 2004

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Linac Vault Sept 2004

Booster Vault Sept 2004

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Storage Ring Tunnel June 2004

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Experimental Hall Sept 2004

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